

Foreword



National
Oceanic and
Atmospheric
Administration



U.S.
DEPARTMENT
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COMMERCE

NOAA Fisheries Service Northeast Cooperative Research Partners Program

The National Marine Fisheries Service (NOAA Fisheries Service), Northeast Cooperative Research Partners Program (NCRPP) was initiated in 1999. The goals of this program are to enhance the data upon which fishery management decisions are made as well as to improve communication and collaboration among commercial fishery participants, scientists and fishery managers. NOAA Fisheries Service works in close collaboration with the New England Fishery Management Council's Research Steering Committee to set research priorities to meet management information needs.

Fishery management is, by nature, a multiple year endeavor which requires a time series of fishery dependent and independent information. Additionally, there are needs for immediate short-term biological, oceanographic, social, economic and habitat information to help resolve fishery management issues. Thus, the program established two avenues to pursue cooperative research through longer and short-term projects. First, short-term research projects are funded annually through competitive contracts. Second, three longer-term collaborative research projects were developed. These projects include: 1) a pilot study fleet (fishery dependent data); 2) a pilot industry based survey (fishery independent data); and 3) groundfish tagging (stock structure, movements and mixing, and biological data).

First, a number of short-term research projects have been developed to work primarily on commercial fishing gear modifications, improve selectivity of catch on directed species, reduce bycatch, and study habitat reactions to mobile and fixed fishing gear.

Second, two cooperative research fleets have been established to collect detailed fishery dependent and independent information from commercial fishing vessels. The original concept, developed by the Canadians, referred to these as "sentinel fleets". In the New England groundfish setting it is more appropriate to consider two industry research fleets. A pilot industry-based survey fleet (fishery independent) and a pilot commercial study fleet (fishery dependent) have been developed.

Additionally, extensive tagging programs are being conducted on a number of groundfish species to collect information on migrations and movements of fish, identify localized or subregional stocks, and collect biological and demographic information on these species.

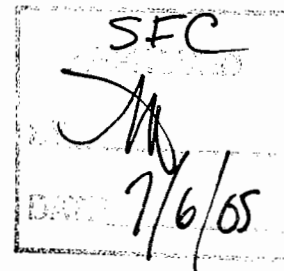
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Date: March 8, 2005
NMFS Grant No. 50-EANF-1-00010



**Final Report: Developing a raised footrope whiting net
in the Gulf of Maine that meets conservation goals
for size selectivity and bycatch.**

1/1/01 - 12/31/02

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Developing a raised footrope whiting net in the Gulf of Maine that meets conservation goals for size selectivity and bycatch.

1. Project Summary and Statement of Research Question:

1. Project Summary

The work done under the current NMFS grant built on the successes in 1999 and essentially completed development of a net that better targets whiting by meeting the double criteria of conservation of the whiting resource and minimization of bycatch of regulated species. Through a series of tests of cod end mesh, raised footrope configurations with and without a roller frame, taking the configuration with the least bycatch from each test, the current research developed a net that met the criteria. This net is a raised footrope sweepless trawl with dropper chains that has a 50 mm bar space Nordmore style grate and 2-1/2 inch stretched mesh cod end. Whiting length frequency retained with this net shows few whiting retained below 22 cm, or roughly size at first maturity. The percentage of bycatch of regulated species is less than 5% for all but a few tows. Continued work during the summer and fall of 2002 with the fishermen involved ensured that proper design and rigging instructions could be developed that would be easily followed, fished and enforced. Sixteen tows with 2-1/2 inch cod end mesh paired with tows with 3 inch cod end mesh conducted during the fall of 2002 showed little difference in length frequency of whiting or in bycatch of regulated species between the two cod ends.

With the completion of this gear development work, Maine worked with the New England Fishery Management Council's Whiting Monitoring Committee on a framework adjustment to create this fishery. This framework adjustment, FW 38, is very specific as to what types of gear may be used in the fishery, ie a raised footrope net with a 50 mm bar space grate and a 2-1/2 inch diamond mesh cod end and defines an area where and a specific time period when the fishery can occur (See Appendix I).

There was a very large whiting fishery along the coast during the 1960's and early 70's and a reasonable fishery during the 1980's, there were little landings during the late 1980's and early 1990's. In 1994, an innovation that helped reduce finfish bycatch in the shrimp fishery, the Nordmore grate, was modified to allow a slightly larger size whiting through the grate, yet keep the bycatch of regulated species down below 5%. The grate bar spacing was widened to 40 mm from 25 mm and testing at sea showed good success at catching whiting and keeping bycatch low. There was no whiting management plan in place at that time and the size fish targeted by this gear, 1 3/4" mesh net and 40 mm bar space grate, was salable in the Spanish whiting market if properly handled on deck to preserve quality. This fishery existed as an experimental fishery under NMFS regulation under the proviso that it proves that its bycatch is less than 5%. Data between sea sampling and logbooks differed as to bycatch percentage. As this work progressed, Amendment 12 to the Northeast Multispecies Fishery Management Plan (MSFMP) was approved in 1999, creating a management plan for the whiting fishery. This plan limited the whiting fishery to only two locations in the Gulf of Maine, Area 1 off Cape Ann, Massachusetts, and Area 2 outside Jeffrey's Ledge. Neither is accessible to the inshore Maine whiting fleet. Submitted in May, 2000, Framework Adjustment 35 to the Northeast MSFMP has allowed an additional whiting fishery north of Cape Cod through use of a raised footrope net. This area has recently been expanded, but is also inaccessible to the Maine fleet. Thus the traditional Maine whiting fishery has been systematically regulated out of existence.

Understandably, after several years of issuing experimental fishing permits for the Maine fishery to prove its worth, the NMFS in 2000 was reluctant to continue to issue experimental fishery permits to sustain the Maine fishery with the whiting grate. Maine fishers hoped that a whiting fishery closer to Maine could be created through another framework adjustment to reestablish this traditional fishery. In order to do so in good conscience, Maine fishers wanted to use the best possible combination of attributes in the net that would meet the dual criteria of low bycatch and conservative size selection for whiting. Amendment 12 to the MSFMP had established a series of increasing limits on daily catch based on decreasing cod end mesh size, which was aimed at limiting the mortality of pre spawning fish.

With a grant from the Maine Fishing Industry Development Program, we continued to work to bring the fishery into compliance with the intent of the whiting fishery management plan to reduce the fishing mortality on juvenile (pre-spawning) whiting. To these ends we investigated increased mesh sizes in the cod end, the addition of a Nordmore style grate into the extension with varying bar spacings and the addition of a modified Massachusetts-style raised footrope to the trawl. Our work met with good success in reducing the catch of small whiting and the bycatch of regulated species. The bycatch of regulated species is calculated as the ratio of the weight of regulated species and the total weight of fish caught. Thus when you greatly reduce the total weight of fish caught by

increasing the cod end mesh to release the small whiting, you run the risk of increasing the percent of bycatch of regulated species, even if you have effectively reduced their actual bycatch. This work ended with a series of trials with a raised footrope that was designed to reduce the bycatch of flatfish and thus bring the bycatch percentage back below 5%. The trials were promising, but not complete enough to be sufficient to recommend their use in the fishery. Also, the video footage that we felt was necessary to document what was happening with the gear while under tow was not clear enough. The current work has addressed these issues and cleared the way for the creation of a whiting fishery along the Maine coast through a framework adjustment (FW 38) to the MSFMP.

Study Design

The project goal for the CRPI grant was to complete the development of a whiting net that can be fished in the Gulf of Maine while successfully meeting the conservation needs of the whiting resource and maintaining acceptably low bycatch levels. The objectives towards this goal were: i. To obtain good video footage of the interaction between the gear and fish and the gear and the bottom. ii. To test 2-1/2" diamond mesh and 2-1/4" square mesh cod ends with a 50 mm bar space grate in combination with a raised footrope net configuration with 30 inch dropper chains both with and without a roller frame for whiting selectivity and bycatch reduction. iii. To sea trial the best combination with several fishers to generate feedback as to the gear's behavior under commercial conditions. iv. To gain acquaintance with and acceptance of the gear within the whiting fishing community.

The testing of the gear involved two vessels conducting paired tows of the test gear and a suitable control net. The catch for experimental and control tows was separated by species and each species weighed, counted and measured for length frequency. Adequate personnel, usually two individuals, were on board each vessel to separate and measure the catch. Comparisons of the diamond and square mesh cod ends were made based on catch and size frequency to determine their equivalence. The video work captured the fishing character of the gear and the behavior of the fish at the footrope of the net. The fishing characteristics of the net were videoed in shallow, clear water. The Scanmar net mensuration gear was unavailable for measuring the net opening width and height and height off the bottom.

Timetable

	2001												2002				2003	2005
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sep	Oct	Nov	Dec	Jan	Mar
Permit applications	*	*																
Gear ordering, constr.	*	*	*															
RFP Sea Sampling		*	*															
RFP Vessel Support			*	*														
Video, Scanmar use contr.				*														
Commercial trials sched.				*		*	*	*										
Raised footrope nets constr.							*											
Video, Scanmar net work							*											
Analysis of video							*	*										
Gear trials							*	*										
Sweepless trawl trials (ext.)													*	*	*	*	*	
3" Cod end trials (ext.)															*			
Analysis of trial results							*	*										
Commercial trials							*	*					*	*	*	*	*	
Data entry, analysis							*	*	*	*			*	*	*	*	*	
Final report										*	*	*				*	*	*
(ext.) = grant extension work																		

Results:

The results of the testing done during the fall of 1999 of the raised footrope trawl with 50 mm bar space grate and 2.6 inch diamond mesh cod end against a control net consisting of a footrope down on the roller frame, a 40 mm bar space grate and 1-3/4 inch diamond cod end were reviewed. See Appendix II for summary results on

catch, bycatch, percent bycatch of regulated species and catch and bycatch by species for the grate bar spacing and cod end mesh trials and the raised footrope trials with 42 inch and 30 inch dropper chains to a roller sweep, or no sweep. Based on those results, it was decided that the reduction in bycatch of regulated species was convincing enough that the current series of tests should concentrate on determining the difference in bycatch of regulated species created by the addition of the raised footrope. Thus the control net was redesigned as being the same as the test net with respect to the bar spacing in the grate and the cod end mesh, but with short dropper chains, bringing the footrope down on top of the roller frame. It was also decided that the video work should be done first to give us the assurance that the nets were properly deploying as designed.

The video documentation was done aboard the F/V Jerry & Joe III during July, 2001. Mike Pol and Arne Carr from Mass. DMF brought their U/W video camera up to Portland and over a period of 3 days were able to generate the footage needed to show that the raised footrope net with and without a roller frame was fishing correctly.

A tow schedule was prepared for the paired tow testing of the nets (See Diagram 1). Paired tows were conducted between September 15, 2001 and October 2, 2001 and tested two net configurations. A second, shorter set of paired tows was done between October 3 and 5, 2001 comparing 2.2" square mesh and 2.6" diamond mesh in the cod ends. A series of 71 tows conducted over 20 days of fishing between October 9 and November 27, 2001 provided commercial trials for the 30" raised footrope with no sweep, 50 mm grate and 2.6" diamond cod end configuration dubbed the 'bottom friendly net' as it has very little contact with the bottom. The two vessels that finally contracted to do the paired towing work were the F/V North Star and F/V Tenacious, Captains Vincent Balzano and Proctor Wells, respectively as the F/V Jerry & Joe sank at the dock and was unable to continue with the work. The F/V North Star was the only vessel to bid on conducting the commercial trials and so was awarded the entire 20 days for the commercial trials.

The paired tows were conducted in five sets. The first set compared the raised footrope trawl with 30 inch dropper chains and 10 inch diameter roller frame towed from the F/V North Star to a control net with no dropper chains and a 10 inch diameter roller frame towed from the F/V Tenacious. Both nets had a 50 mm bar space grate and 2.6 inch diamond cod end. There were 8 paired tows in this set and the per tow information for date, time, gear, location, depth, weight of catch, weight of regulated species bycatch and percent of regulated species bycatch are found in Table 1. This raw data showed the F/V North Star caught more total fish and less regulated species with the raised footrope net for a mean percent bycatch of 7.5% than did the F/V Tenacious with 14.9% with the control net. The length of tow between pairs was not always completely comparable, so the catch, bycatch and percent bycatch have been standardized to a per hour towing basis and are presented on both a per tow and a per trip basis (Table 2). In this initial set of tows, some tow information was not recorded, so per hour information is not complete. The percent bycatch showed some marginal improvement, with 18.3% for the control and 4.3% for the raised footrope net. Individual species catches in weight for the raised footrope with roller frame tows and the control net tows are summed in Table 3a and catch in numbers are summed in Table 3b for the raw data. Mean catch in wt per hour tow by species for the two nets is listed in Table 4. The majority of the catch in all tows was whiting and red hake. White hake, American plaice and gray sole comprised the bulk of the bycatch of regulated species. Selected species weights and numbers by paired tow for the raw data are compared for the two nets in Table 5. American plaice, gray sole and white hake were selected because they are the major bycatch species and they represent the two basic fish shapes, flat and round. Red hake and silver hake were chosen as they were the major components of the catch and monkfish was chosen as it is a commercially important bottom dweller that wouldn't fare well in cod end selectivity due to its shape and thus shouldn't be allowed to enter the net. The F/V North Star with the raised footrope net with frame caught more fish in general than did the F/V Tenacious with the control net as seen in the paired tows. Silver hake and red hake were higher and the bycatch of gray sole was up, but the bycatch of white hake and American plaice were about the same, producing a lower percent bycatch for the raised footrope net. Length frequency and percent length frequency of the same selected species for the raised footrope with roller frame and control nets show little difference in size selectivity between the two nets (Figures 1&2).

The third set of paired tows repeated the set, but with the net from the Tenacious rigged as the raised footrope trawl with inch dropper chains and 10 roller frame and the F/V North Star's net rigged as control. There were 9 paired tows in this set. The tow information is found on bottom half of Table 1 and shows the F/V Tenacious caught about half as much as the F/V North Star for total catch and bycatch and had about the same percent bycatch of regulated species, 8.4% vs 7.7%. The catch, bycatch and percent bycatch hour tow and per trip for this set are found in Table 2 and show the same general characteristics with around bycatch for both nets. Individual species catches in weight for the tows in the set are summed in Table 6a the catches in numbers are summed in Table 6b for the data. Mean catch in wt per tow by species for the two in the third set is listed in Table 4. The experimental caught about half the whiting, which was the bulk the catch, but about the same amount of red hake white hake. The weight of dabs and gray sole was about half that of the control. Selected species weights and numbers by paired tow for the raw data, compared for the two nets in Table 7 showed no remarkable fluctuations in catches between tows. While there were reductions the amount of flatfish taken, most noticeable result was large reduction in monkfish the raised footrope net. Length frequency and percent length frequency for selected species from this second set for the raised footrope with roller frame and control nets show little difference in size selectivity between the two nets (Figures 3&4). The length frequency data

Diagram 1:

Paired Towing Schedule: F/V North Star and F/V Tenacious.

Tows should be between one and two hours duration, of equal time between vessels for each pair of tows and as many pairs of tows as can reasonably be done in a day's fishing. IE, if 2 hour tows, 5 or 6 pairs might be done. If 1 hour tows are done, 10 to 12 pairs might be done. Tow time may be tuned to how long it takes to measure up a tow of fish.

Tow logs and length frequency logs are to be the standard NMFS sea sampling logs.

Gear to be tested: Net with grate bar spacing of 50mm and cod end mesh size of 63.5mm (2-1/2") diamond mesh (DIA), or 56mm (2-1/4") square mesh (SQ) and

1. Raised footrope w/dropper chains only (F1)

2. Raised footrope w/roller frame (F2)

Control net: Shrimp mesh w/ grate bar spacing of 50mm and cod end mesh size of 63.5mm (2-1/2") w/ footrope down on roller frame (C).

Tow schedule:

Day 1:

Raised Footrope w/roller frame vs control

Vessel 1	Vessel 2
F1	C
F1	C
F1	C
F1	C
F1	C

Day 2:

Raised Footrope w/no roller frame vs control

Vessel 1	Vessel 2
F2	C
F2	C
F2	C
F2	C
F2	C

Day 3:

Raised Footrope w/roller frame vs control

Vessel 1	Vessel 2
C	F1
C	F1
C	F1
C	F1
C	F1

Day 4:

Raised Footrope w/no roller frame vs control

Vessel 1	Vessel 2
C	F2
C	F2
C	F2
C	F2
C	F2

Day 5:

Raised Footrope w/roller frame vs control

Vessel 1	Vessel 2
F1	C
F1	C
F1	C
F1	C
F1	C

Day 6:

Raised Footrope w/no roller frame vs control

Vessel 1	Vessel 2
F2	C
F2	C
F2	C
F2	C
F2	C

Day 7:

Raised Footrope w/roller frame vs control

Vessel 1	Vessel 2
C	F1
C	F1
C	F1
C	F1
C	F1

Day 8:

Raised Footrope w/no roller frame vs control

Vessel 1	Vessel 2
C	F2
C	F2
C	F2
C	F2
C	F2

Day 9:

Raised Footrope w/roller frame: 2.2 inch Sq mesh cod end vs 2.6 inch Diamond mesh cod end.

Vessel 1	Vessel 2
SQ	DIA
DIA	SQ
DIA	SQ
SQ	DIA
SQ	DIA
DIA	SQ

Day 10

Raised Footrope w/dropper chains only: 2.2 inch square mesh cod end vs 2.6 inch diamond mesh cod end.

Vessel 1	Vessel 2
SQ	DIA
DIA	SQ
DIA	SQ
SQ	DIA
SQ	DIA
DIA	SQ

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shows much fewer flatfish (plaice, sole), monkfish and silver hake caught with the raised footrope with frame net than with the control and about the same number of red and white hake, but no changes in the relative numbers at size. The difference between the two net/vessel combinations shows the F/V North Star caught more fish than the F/V Tenacious in both the raised footrope and control configurations and this confounds the comparison between gear.

If you compare each vessel to itself, raised footrope to control, in both cases the raised footrope net reduced the bycatch and percent bycatch of regulated species by about half, from 25 kg to 12 kg, or 18% to 8% for the Tenacious and from 22 kg to 11 kg, or 9% to 4% for the North Star (Table 2).

The second set of paired tows compared the raised footrope trawl with 30 inch dropper chains and no roller frame towed from the F/V North Star to a control net with no dropper chains and a 10 inch roller frame towed from the F/V Tenacious. Both nets had a 50 mm bar space grate and 2.6 inch diamond cod end. There were 9 paired tows in this set and the per tow information for date, time, gear, location, depth, weight of catch, weight of regulated species bycatch and percent of regulated species bycatch are found in Table 8. Of the 9 tow pairs, two of the experimental tows were no good, leaving 7 paired tows. The raised footrope with no roller frame trawl caught a third less fish than the control, but the bycatch was reduced from 45 kg to 6 kg, or 20% down to 3%. The catch, bycatch of regulated species and percent bycatch, standardized to a per hour towing basis are presented on a per tow basis and the tows are summed to a per trip basis (Table 2). The percent bycatch reduction is the same, 20% down to 3%, whether calculated on a per tow or a per trip basis. Individual species catch in weight for the raised footrope with no roller frame tows and the control net tows are summed in Table 9a and catch in numbers are summed in Table 9b for the raw data. Mean catch in wt per hour tow by species for the two nets is listed in Table 10. Selected species weights and numbers by paired tow for the raw data are compared for the two nets in Table 11. Length frequency and percent length frequency for selected species for the raised footrope with no roller frame and control nets show little difference in size selectivity between the two nets except for monkfish, which were not captured as frequently at the smaller sizes with the raised footrope net (Figures 5&6).

The fourth set of paired tows repeated the second set, but with the net from the F/V Tenacious rigged as the raised footrope trawl with 30 inch dropper chains and no roller frame and the F/V North Star's net rigged as the control. There were 10 paired tows in this set. The raw per tow information, on the bottom half of Table 8, shows the control caught about twice what the experimental net. This isn't surprising as the North Star regularly out-fished the Tenacious in these trials. The sweepless raised footrope trawl caught about a third as much regulated species as the control, so the percent bycatch was less, 2.9% vs 5.0%. The catch, bycatch of regulated species and percent bycatch, standardized to a per hour towing basis are presented on a per tow basis and the tows are summed to a per trip basis (Table 2). The per trip percent bycatch was 4.6% for the control and 3.0% for the sweepless raised footrope net. Individual species catch in weight for the raised footrope with no roller frame tows and the control net tows are summed in Table 12a and catch in numbers are summed in Table 12b for the raw data. As with the first set of paired tows with the sweepless net, the raised footrope caught a lower amount of flatfish relative to the control than it did white hake. Flats were reduced by 75% compared to 65% for white hake and 53% for silver hake. Mean catch in wt per hour tow by species for the two nets shows the same differences (Table 10). Selected species weights and numbers by paired tow for the raw data compared for the two nets again shows monkfish being caught in consistently very low numbers with the raised footrope trawl and flatfish released more than white hake (Table 13). Length frequency and percent length frequency for selected species for the raised footrope with no roller frame and control nets show little difference in size selectivity between the two nets even for the monkfish (Figures 7&8).

The fifth series of paired tows were made using diamond and square mesh cod ends to see if any difference in size selectivity was detectable. The diamond mesh was the same 2.6 inch mesh used throughout these experiments and the square mesh was 2.2 inch mesh stretched measure. Eight paired tows were made in all with the square mesh towed for four tows by each vessel. Both vessels used the raised footrope sweepless trawl, the raised footrope with sweep and the footrope down on the sweep in various tow pairings (Table 14). Length frequency comparisons for selected species showed no striking differences in selectivity for any species, although there may have been some increased release of small gray sole through the diamond mesh (Figure 9).

The F/V North Star used the sweepless trawl for another 20 days in October and November 2001 as part of the commercial testing/introduction segment of the work. A total of 71 tows were made of which 65 were good, clear tows without problems. The per tow information as well as the catch, bycatch of regulated species and percent bycatch are found in Table 15 and show very low bycatch (2.2 kg/hr) and percent bycatch (2.5%) of regulated species even though the whiting are no longer available inshore in any appreciable numbers at this time of the year (69.6 kg/hr).

During the fall and early winter of 2002-03, a series of tows were made from September through January, 03 using the 50mm bar space grate raised footrope sweepless trawl with 2-1/2 inch mesh cod end to document catch

of whiting and bycatch of regulated species over a wide area along the coast of Maine to define what area to ask for in Framework 38 for the fishery. Also, a final set of paired tows was conducted during the fall of 2002 to compare catch and bycatch with 3" cod end mesh compared to 2-1/2" mesh. The F/V North Star and F/V Tenacious were involved in both efforts. The F/V Tenacious towed the gear in September, 2002, December, 2002 and January, 2003 and made 21 tows that were free of troubles. The date, location, depth and other tow characteristics as well as total catch, whiting catch and regulated species catch and percent regulated species by tow and by trip are recorded in Table 16. Mean percent bycatch of regulated species was 3.79% per tow and 3.59% per trip. Occasional high percent bycatch were created by low levels of whiting in a tow with no increase in the regulated species caught over other tows (Table 16). Catch rates by species for each tow showed consistently low levels of bycatch dominated by herring and alewives (Table 17). Occasionally spiny dogfish would get tangled in the funnel in front of the grate and were weighed and measured as part of the catch. They were too large to go through the grate, so in a sense shouldn't be counted. The summary of total catch per tow and mean catch per tow by species shows a mean percent regulated species of 3.5% (Table 18). If the dogfish are removed from the total catch, the percent bycatch of regulated species rises to 4.5%, which is still respectable. The length frequency of whiting taken with this gear shows that the majority of whiting are over the minimum size for sexual maturity, 22 cm (Figure 10) which meets the goal of conserving the stock by limiting fishing mortality on juvenile fish.

The F/V North Star made 43 tows during October and November, 2002 of which 36 were good, clean tows without tearups, hangs, or using other gear. These tows complemented the tows made by the F/V Tenacious to provide a continuous series of tows throughout the fall. The date, location, depth and other tow characteristics as well as total catch, whiting catch, regulated species catch and percent regulated species by tow and by trip are recorded in Table 19. They show variable levels of catch in all three categories and two extraordinary catches of redfish, bumping the percent bycatch of regulated species for those tows to 39% and 58%. These helped to raise the mean percent bycatch of regulated species per trip to 5.80%, where without them, it would have been 3.19% for the 11 trips made. The catch by species per tow and percent bycatch regulated species per tow show a steady, low level of catch for the regulated species with the few notable exceptions (Table 20). Sometimes these translate into high bycatch percentages if the whiting catch is low for that tow. The summary total catch per tow and mean catch per tow by species shows the major regulated species bycatch to be redfish, followed by white hake, American plaice and gray sole with a percent bycatch of 5.11% (Table 21). The length frequency of whiting for this series of tows (Figure 11) is very similar to that for September, December and January (Figure 10). The percent length frequency for the two tow series shows that the whiting caught by the F/V North Star in October and November are a little larger on average, by about a centimeter (Figure 12). No difference in the gear is apparent, so it may be that the location fished was a little different, or that the size frequency available to the gear was slightly different during that period.

The length frequencies for the regulated species taken by the F/V North Star show a bimodal distribution for redfish, but the other three species, white hake, American plaice and grey sole are all unimodal in their size distribution (Figure 13). The frequencies are for total catch and show that redfish was the dominant regulated species in the catch. While white hake was second in weight, it was third in numbers behind American plaice, but was comprised of larger individuals. The mean size of grey sole retained was larger than the mean size for American plaice, perhaps indicating a difference in cod end mesh selectivity based on the body firmness of the fish.

The frequency of tows exhibiting low levels of bycatch of regulated species is much greater than the frequency of tows with high levels. 80% of the 61 tows made between the two vessels showed bycatch level below 5% (Figure 14). The distribution of bycatch of individual regulated species by tow shows the rare high bycatch level of redfish and the more even elevated level of bycatch of white hake (Figure 15). The other species show variable, but generally low levels of take.

The distribution of bycatch of regulated species over the season and over depth was of interest in deciding what time of year to ask for in a fishery and what area along the coast to ask for in generating a fishery for whiting. The distribution of bycatch by depth showed little change over a depth range of 48 to 89 fathoms (Figure 16). The two high redfish catches were both in water over 70 fathoms, but other than those two tows, there is only a slight rise in bycatch levels with increasing depth. Indeed if you look at the total catch, whiting catch and regulated species catch per tow distribution over depth, there is a wide variability, but no discernable change with depth. The R squared values for linear regression with depth show no pattern associated with depth for any of the three catch levels (Figure 17). The percent bycatch of regulated species shows no relationship with total catch, however, the two high percent bycatch of redfish tows were both associated with lower than average total catch as were the two elevated white hake percent bycatch levels, thus there seems to be a greater chance of high percent bycatch if the total catch is low (Figure 18). The distribution of percent bycatch of regulated species over time from September,

2002 through January, 2003 showed no discernable change over time (Figure 19). All of the high bycatch levels (over 10%) occurred mid-season between mid October and mid November.

A comparison of catch and bycatch between 2-1/2 inch and 3 inch cod end mesh was carried out in November, 2002 using the Grate raised footrope sweepless trawl. A series of 16 paired tows were made with the F/V Tenacious and the F/V North Star. Cod ends were switched between vessels to provide an even split between the two vessels of experimental and control cod ends and to negate vessel effects. The date, location, depth and other tow characteristics as well as total catch, whiting catch, regulated species catch and percent regulated species by tow are recorded in Table 22. The catch by species by tow for the 3 inch cod ends shows variable catch rates for all species with whiting catches ranging from 4.4 kg to 90 kg (Table 23). In general, when whiting catch rates are high, percent bycatch is low. A few tows showed elevated catches of white hake, American plaice and grey sole relative to whiting, and one tow showed a very high catch of redfish, producing a high percent regulated species bycatch of 80%. This was also due in part to a comparatively low whiting catch. Only five of the 16 tows with the 3 inch cod end produced a bycatch of less than 5% and the mean regulated species bycatch rate was 20% (Table 23). The mean catch per 60 minute tow for 3 inch cod end tows was 10.6 kg, which was somewhat higher than the catch of regulated species for the tows done with the 2-1/2 inch cod end during the fall, 5.8 kg and the average total catch, 66.8 kg was lower than the average of 100.5 kg for the 2-1/2 inch cod end tows. Thus the high percent bycatch is due to a combination of higher bycatch weights and lower total catch weights. The 2-1/2 inch cod end fared a little better in percent bycatch of regulated species with a range of 3.2% to 28.3% and a mean of 10.7% for a 60 minute tow discounting the spiny dogfish catch (Table 24). The primary purpose of these tows was to see if the 3 inch cod end could be used to catch whiting and still maintain low bycatch. The bycatch of regulated species between the two cod ends was pretty comparable if the catch of large dogfish ahead of the grate was discounted and the one high redfish tow was discounted, producing 11.5% +/- 0.072 std. dev. for the 2-1/2 inch cod end and 9.2% +/- 0.065 std. dev. for the 3 inch cod end (Tables 23, 24). The summed catch by species and the mean catch by species for a 60 minute tow for the two cod ends (Table 25) shows that the distribution of fish for both cod ends is dominated by whiting and red hake, with white hake, American plaice and grey sole and an occasional high take of redfish comprising the majority of regulated species bycatch. The length frequency for the whiting retained showed little difference between the two cod ends (Figure 20) and both retain whiting predominantly over minimum spawning size. Thus from a whiting conservation standpoint, either cod end would be acceptable.

Summary of results and discussion: The raised footrope with the roller frame was tested in two sets of paired tows with the gear reversed between vessels between the two sets. In one set, the percent bycatch was reduced significantly to a level below 5% and in the other set it remained the same, at about 8%. These results are confounded by one vessel catching consistently more than the other, regardless of gear used. If you compare each vessel to itself, you see that the raised footrope with roller frame reduced the weight of bycatch to about half and in one case that brought the percent bycatch below 5% and in the other case it didn't. This may be helpful as the difference in how the two vessels had rigged their gear will be instructive in describing just how nets must be rigged in order to achieve the desired reduction in bycatch. Future work to be done this summer should shed light on this issue.

The raised footrope with no roller frame, dubbed the bottom friendly net, was also tested with two sets of paired tows and proved to reduce bycatch and percent bycatch better than the raised footrope with the roller frame achieving much less than 5% in both pairings. The difference between the nets in overall catch was still evident, but the bycatch weight reduction was sufficient to overcome this difference and produce low percent bycatch levels.

Differences between the two raised footrope nets and their respective control nets in catch of individual regulated species were consistent. Both raised footrope configurations did a better job of reducing flatfish and monkfish bycatch than they did white hake bycatch, however white hake bycatch was reduced as well.

No appreciable differences in size selectivity were observed between any of the trials, including the diamond mesh versus square mesh cod ends. This is not surprising as the nets used in all trials except the square mesh vs diamond mesh trials used the same grate bar spacing and cod end mesh for both experimental and control nets. The difference between them was in the configuration of the footrope.

During the fall of 2002 we further tested the raised footrope without a sweep for several reasons. It is important to understand what level of description of the gear is needed to put a fishery in place based on the successful use of this gear. Tows were conducted over a wide area as the scope of what area is eventually opened to whiting fishing may well depend on what area we have data from. Also, we developed a time series of samples to test for changes in bycatch with season and tested for variation in bycatch with depth. There were only slight

differences in bycatch with season, depth and location, justifying the request for a whiting fishery over a respectable area of bottom and over several months a year.

Testing the 3 inch diamond stretch mesh cod end in conjunction with the 50 mm bar space grate and raised footrope without a roller frame for bycatch was done because this mesh size is the current default mesh in the whiting FMP. If a Gulf of Maine whiting fishery is created based in part on this research and the default mechanism is invoked, the fishery may close as we would have no data on what bycatch would be with the 3 inch mesh. While the percent bycatch of regulated species was higher during these 3 inch cod end trials for both the 3 inch cod end and the 2-1/2 inch cod end, even compared to tows done around the same time of year with the 2-1/2 inch cod end, they were not wildly different from each other and were influenced by low total catch rates and occasional high bycatch rates.

Overall, the testing of the raised footrope sweepless trawl with 50 mm bar spacing in the grate over the past three years has shown uniformly low bycatch levels of regulated species over a wide range of locations, times of the year and depths. A total of 174 tows were made with a mean percent bycatch of regulated species of 3.9% with a standard deviation of 5.78. This data was sufficient to allow Framework Adjustment 38 to be approved by the New England Fishery Management Council, reinstating a whiting fishery along the Maine coast.

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